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# R E P O R T

OF THE

COCHITUATE WATER BOARD,

TO THE

CITY COUNCIL OF BOSTON,

FOR THE YEAR 1854.



B O S T O N :

1855.

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E. S. Chestnough

July 24, 1858



# R E P O R T .

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OFFICE OF THE COCHITUATE WATER BOARD,  
*February 1, 1855.*

*To the CITY COUNCIL of Boston.*

The Cochituate Water Board, in conformity with the provisions of the City Ordinance, respectfully present their Annual Report for the year 1854, and also transmit the several reports of the City Engineer and Water Registrar, made to them pursuant to the same ordinance, to which they would beg leave to refer the Council for full details of the state of the Water Works, and of the various transactions of the year relating to them.

The Water Board feel gratified in being able to state that the general condition of all the Works, comprehending the structures at the Lake, the aqueduct, reservoirs and distributing mains and pipes, is quite satisfactory.

The repairs on the brick Aqueduct, which have been brought to the notice of the City Council, in previous reports of the Water Board as being in progress, are now completed; and various leaks and fissures, some of which had existed from the laying of the works, and

had been a source of anxiety, from their endangering the stability of the structure, by causing the foundation to be undermined or washed away, have been, it is believed, effectually and permanently stopped.

The subject of the accretions in the pipes, which has also formed a considerable topic of former reports, has continued to attract the attention of the Board. Our previous anticipations in relation to their future progress,—viz. that their rate of increase would diminish,—seems to be, to a great extent, confirmed. The researches and experiments of Professor Horsford, instituted for the purpose of ascertaining their precise origin, and of discovering, if possible, the means of preventing it, have been still further pursued; and are, as we hope, now nearly and successfully completed. By a reference to a communication from him hereto annexed, it will be seen that in his opinion the cause of the accretions has been most satisfactorily ascertained, and a confident expectation, founded on the results of actual experiment, is expressed of the possibility of effectually protecting the metal from them.

The extension of the works by laying distributing and service pipes in new streets, &c., has been continued during the year, wherever it was called for, and when the rule originally adopted by the Board, requiring the assessment of a water rate equal to six per cent. on the cost, was complied with.

The operations chargeable to this head have been much diminished, the amount of distributing pipe laid having been 3,976 feet less than the previous year.

The length of Distributing Pipes of 4, 6, and 12 inches diameter laid during the year is 9,014 feet, and 19 stop-cocks were affixed. The whole length of pipes of 4 inches and upwards now laid, including hydrant branches and bends, is nearly 110 $\frac{1}{2}$  miles.

The whole number of Stop Cocks is 960.

The number of Service Pipes laid during the year is 659, the length of which is 24,893 feet. The whole number is 17,999.

The number of Hydrants established during the year is 25. The whole number is 1,210.

The whole number of leaks repaired in pipes of 4 inches and upwards was 74. The last year it was 85.

The whole number in those of less than 4 inches was 280. The last year it was 260.

The supply of water from Lake Cochituate has been amply sufficient for all the public, domestic, and manufacturing uses to which it has been applied, notwithstanding a greatly increased consumption, of more than a million and a half gallons daily, and also the long and severe drought which prevailed during the summer and part of the fall, by which the lake was deprived of the supply usually received during that period.

The gates at the outlet dam were closed on the 30th of May, the water then being 7 feet  $3\frac{1}{2}$  inches deep above the flume. The water was gradually drawn off for consumption in the City, and also lost by evaporation, with scarcely any compensating supply from rain, until the 10th day of November, when it stood at 2 feet  $1\frac{1}{2}$  inches above the flume, or 5 feet 1 inch below the point where it was when the gates were closed, and nearly 2 feet lower than it had been before since the construction of the works. Since that time it has been rising, and on the 1st of January it was 6 feet above the flume.

The quantity delivered at the Brookline Reservoir, and brought into the City, was 3,614,243,335 wine gallons, being a daily average for the year of 9,902,000 gallons.

Deducting from this amount a large estimate of the quantity probably lost by leakage in Roxbury, as stated in the City Engineer's report, the consumption in the City appears to have been more than 60 gallons for each inhabitant. The greatest daily average consumption took place in the month of June, the least in November, and there was an increase in the consumption every month over that of the corresponding months of last year, except in the months of October and November, when it was less.

The rain-fall, calculated from gauges kept in various places, as stated in the report of the City Engineer, was 44 inches. The quantity which fell on the whole water-shed is therefore assumed to have been about 14,467,038,300 gallons. The quantity wasted from the outlet of the Lake is estimated at 3,733,541,000 gallons.

The amount received on account of Water Rates during the year, including those for Jamaica Pond, and also for shutting off and letting on water for non-payment of water rates, for repairs, and for unnecessary waste, and also for laying service pipes, has been \$222,924.70, being \$25,734.38 more than the amount received from the same sources the last year. The estimated receipts for the ensuing year are \$256,000. The Report of the Water Registrar contains a statement in detail of the particular amounts received from the different sources, and also of the several tenants to whom the water has been supplied, of which the following abstract has been prepared and collated with a similar statement of the last year.

1853.	1854.		1853.	1854.
13,632	14,073	Dwelling houses - - - -	\$119,891.18	\$124,977.06
2,845	3,031	Stores, shops, offices, cellars, &c. -	16,006.93	18,242.25
283	299	Hotels, restaurants, and saloons -	6,459.57	10,302.09
480	518	Stables - - - - -	6,515.38	6,869.14
8	7	Railroads - - - - -	6,527.20	5,912.28
2	3	Ferry Companies - - - - -	1,006.53	2,115.64
16	21	Steamboats - - - - -	3,055.81	3,211.85
932	811	Hose - - - - -	2,829.00	2,452.00
1	1	Motive power - - - - -	535.51	783.44
63	67	{ Sugar refineries, distilleries, brew- }	6,635.93	7,303.49
3	4	{ eries, and bakeries - - - }	514.47	508.76
		Gas Companies - - - - -	16,247.23	18,738.22
		Other manufacturing purposes -		3,733.50
		City buildings and other City uses -	1,053.83	1,627.92
		Public buildings, charitable institu- }	3,900.06	4,647.08
		tions, &c. - - - - -	655.88	532.45
		Shipping contract with watermen -	609.93	917.40
		Street waterers - - - - -	1,544.00	1,479.50
		Building purposes - - - - -		
		Other purposes - - - - -		
			\$193,988.44	\$214,354.07

To the above must be added one railroad, where the amount due is not as yet precisely adjusted, and a sugar refinery, in which a question has been raised by the proprietors as to the accuracy of the water meter, in consequence of the very large quantity of water which it indicates to have been used.

The total number of water takers entered for the present year is 19,193, being an increase of 1,023 over the last year.

The water has been shut off in 2,325 cases, and it has been let on in 2,741 cases. Repairs have been made in the service pipes, streets, &c., in 446 instances.

For the purpose of discovering the places where the water was suffered to run to waste unnecessarily, two persons were appointed early in the year as Inspectors, whose duty it was to visit the different parts of the city in the night time, and to report to the Water Registrar's Office the cases where any inordinate waste



could be detected, and notice was thereupon given to the parties that their supply would at once be cut off. In most cases this was not done, the parties agreeing to prevent the occurrence in future, and paying the amount prescribed in the ordinance. The Inspectors performed this duty solely for about two months, and were afterwards employed to some extent for the same duties, but more generally in other business of that office during the year. The number of cases of waste reported was 731, the amount paid on account of the same was \$1462, being more than the compensation paid to the Inspectors for all their services during the year. In many of the cases the waste detected was apparently reckless and entirely useless; in others it was caused for the purpose of preventing freezing in the pipes, but the quantity wasted was exorbitant, and altogether beyond what was necessary for the purpose required.

It is believed that the measures thus adopted were the means of preventing much waste in certain places. It is obvious, however, that the Inspectors could only detect it in cases where it could be actually seen, as, for instance, from hydrants; or where the discharge was so large that it could be heard in the adjoining streets. The quantity used at the time in the City very clearly proves, however, that there must have been as profuse wastefulness prevailing in other places, not exposed to the inspection of the City officers, and which at one time produced so great a loss of head as to threaten somewhat serious consequences. During the month of January the daily average was 10,800,000 gallons; on the 25th of that month it was 11,000,000, on the 26th 13,100,000, and on the 28th and 29th upwards of 14,000,000. The reservoirs at South Boston and on Beacon Hill were entirely drained, and there

was only  $3\frac{1}{2}$  feet of water left in that at East Boston, and there was a failure of supply in many houses on Mount Vernon, Fort Hill, and the higher parts of Broadway. Had a fire occurred at the time, it would have been difficult to foresee the extent of the damage which might have been caused.

It was stated in the last annual report that the Board had been directed by an order of the City Council to revise the tariff of Water Rates, and to report the same at an early day to the City Council. The Board accordingly submitted a new tariff to the City Council, in which they proposed to increase the revenue derived from the Water Rates so that it might approximate more nearly to the annual interest payable on the water loan. They therefore suggested the addition of one dollar to the water rate on each dwelling-house,—a specific rate on various kinds of water fixtures, when used in any other places than dwelling-houses,—an increased rate on stables, and also for water when drawn in large quantities for manufacturers and other like purposes. They also proposed, for the purpose of preventing and discontinuing the use of certain descriptions of water closets, where a large and inordinate quantity of water is wasted, to charge them, wherever used, with a very high water rate.

The tariff thus submitted was not adopted by the City Council, except the additional charge of one dollar to dwelling-houses. Instead of it, the only other alteration made in the existing tariff was a rate of five dollars upon each dwelling-house where a water closet or bathing tub is used. It makes no distinction, therefore, between the different kinds of those fixtures, and only charges for them when used in dwelling-houses, allowing the use of one in various other places without charge. The alteration will produce a considerable



increase in the income, but we would respectfully suggest whether it does not hold out an inducement for the construction of the most wasteful kind of fixtures, as they are the cheapest, and impose an onerous tax on dwelling-houses, already assessed not according to the quantity of water used in them, but to their valuation by the assessors.

## RECEIPTS AND EXPENDITURES.

By the Account of Receipts and Expenditures hereto annexed, the same appear to have been as follows, viz.:

The whole Amount drawn from the City Treasury was	\$80,182.35
From which deducting the Amount	
paid for unsettled claims for land	
and water rights - - - -	\$14,713.52
Extension of the Works - - - -	31,519.35
	<hr/>
	46,232.87
	<hr/>
Amount of Current Expenses - -	33,949.48
The whole Amount of Receipts (in addition to those charged in sundry accounts, and excepting water rates) was	
For Rents and Sundries, paid to the	
City Treasurer - - - -	12,423.29
	<hr/>
Balance - - - - -	\$21,526.19
	<hr/>

The Water Board have at last the pleasure of being able to state that the only outstanding claims for damages, occasioned by the original construction of the Water Works, have been finally settled by the adjustment which has been effected during the past year of those made by the mill owners on Concord River, and by the Middlesex Canal Corporation, for being deprived of the water of Lake Cochituate. These claims were originally ten in number, and the aggregate amount of damages sued for was nearly half a million of dollars.

Two of them were tried, in one the jury could not agree in a verdict; and in the other, where the damage laid was \$150,000, they awarded \$500. A proposition was then made for the discharge of all the claims, and they were finally settled and discontinued by the payment of the sum of \$6,678.90, on the part of the City.

Taking into consideration the large amount claimed by the several parties, the uncertainty as to what would be the views which different juries might entertain of the law and evidence in the various suits, and the expense and trouble which would necessarily attend the trial and defence of them, it is very confidently believed that the arrangement which has been made is eminently advantageous to the City. And, in addition, it may be also stated that the City has now the power of disposing of the Compensating Reservoirs in Hopkinton and Marlborough, and Boon and Ramshorn ponds, near the latter, which were originally purchased and improved at an expense of upwards of \$72,000, for the purpose of supplying Concord River with water during the dry season, and thereby lessening the damages which it was feared might be occasioned by depriving it of the water of the Lake. It will be the endeavor of the Board to effect a sale of the above property as soon as a purchaser at any reasonable price can be found.

The Water Board confidently trust that the present state and future prospects of the Water Works, as far as they are dependent on the subjects already referred to in this Report, must be the source of satisfaction to all who feel in any way interested in their success. The supply of water in the Lake is ascertained, more especially by our experience during the drought of the past season, to be far greater than was originally calculated; as is also the capacity of the aqueduct; various imperfections which existed in parts of the works from

the beginning have been remedied, and their permanency and durability more certainly ascertained or established; the annual cost of carrying on the works has been much diminished, and there is a probability of its being hereafter still more so; and the income is gradually increasing, the receipts for the past year being \$53,407, and the estimate for the next year, under the new water tariff, being upwards of \$95,000 greater than those of 1851; and a great variety of claims for compensation and damages, to a vast amount, and quite uncertain as to their results, have been settled and got rid of, and on terms, in the aggregate, far more favorable to the City than had been originally anticipated.

While, however, the Water Board would congratulate the City Council that the experience of the past year has thus borne its additional testimony to those which have preceded, in confirmation of the most sanguine anticipations which were originally entertained of the sufficiency of the supply of water from the Lake for all the uses of the City, they regret to be obliged to report upon a deterioration in the quality of the water, which has recently been, most unexpectedly, found to be so universally prevalent, as to be not only a source of much annoyance to every water taker, but also of solicitude to all who feel an interest in the welfare of the City. It was first observed in October last, and consisted of a marked and peculiar taste, resembling, in the opinion of some, that of fish, but we believe in that of a great majority of persons, that of cucumbers or some similar vegetable, the taste being sometimes accompanied by a disagreeable smell.

On the presumption that it was local in its origin, and in fact confined to the circulation in the mains and distributing or service pipes, they were all forthwith thoroughly flushed out. This operation, together with

the change of the water produced by the ordinary consumption (by which alone, as the pipes will hold but little more than  $3\frac{1}{2}$  million of gallons, and the consumption was at the time over 9 millions, the whole body of water in them is discharged oftener than twice in twenty-four hours), it was hoped, would be a sufficient remedy for the trouble; as it certainly would remove all sources of impurity originating in or confined to the pipes themselves. It was, however, not the case; indeed, in most instances the impurity seemed to be actually increased by the operation. There were also other anomalies quite difficult to account for. The water, for instance, in the *dead ends*,—that is, in the pipes which terminate abruptly, without being connected with others, as those laid in courts, &c.,—was frequently proved to be uninfected; although the circulation in those places, being subject only to the actual draught of residents there, would be necessarily quite sluggish, and the water naturally become stagnant and impure; and, on the other hand, in other larger pipes, where the current was continuous and rapid, it was quite offensive.

It was also satisfactorily ascertained that the water, after being drawn a few days, lost all its repulsive character and became tasteless. There was in no case any appearance of fish or any other foreign matter in the water discharged from the hydrants or stop-cocks, nor any stoppage in any of the service pipes, which must be the case when any fish get into them. It seemed, therefore, requisite to look beyond the limits of the City for the origin of the difficulty, and upon examination it was found that the water in the Brookline Reservoir and the Lake was affected in precisely the same way. For the purpose of a thorough investigation of the subject, it was then deemed expedient to



have the water in the City and the Lake analyzed by scientific chemists, in whom the public would have confidence, and whose opinion as to the nature and origin of the evil, and the prospect and mode of relief from it, would have due weight and authority.

Professor Horsford, of Cambridge, and Dr. C. T. Jackson, of this City, were accordingly appointed for this purpose. They proceeded to the Lake and carefully examined the water in different parts of it, and at different depths; and also some part of the surrounding water-shed; and made a careful analysis of the water at the Lake and also in different parts of the City, without any disclosure being made to either of them of the places whence the several specimens of water had been taken. The result of their inquiries is contained in their respective reports which were made to the Water Board and published by its direction in the public prints, in order to relieve, as soon as possible, the anxiety on the subject which very generally prevailed. The reports were made and the investigation conducted by their respective authors independent of each other, and without mutual consultation, and they did not, indeed, see each others reports until they were printed. The communications contain a great variety of interesting information, and the subject of them is discussed so minutely and elaborately that they are deemed worthy the special consideration of the City Council and a permanent preservation for future reference. The Water Board would therefore beg leave to make them a part of their Report. It will be found that both the Reports came to the same conclusion with that which had been previously suggested in a communication made by order of the Board,—viz., that the impurity complained of is derived from vegetable decomposition existing in the Lake itself,—that it might be attributed

to the unusually long and severe drought of the last summer and to the subsequent rains acting on the peculiar soil of part of the Lake and over the whole water-shed,—and that complete relief might be anticipated from the natural agency of the approaching cold and rains.

A brief description of Lake Cochituate, the source of supply of water to the City, may be acceptable to such members of the Council as are not at present familiar with it, as affording them some means of forming a more satisfactory opinion on the subject. The Lake is about  $3\frac{1}{2}$  miles in length in a direct line, the contour of the margin being upwards of 12 miles. It is separated almost completely into three nearly equal divisions, connected with each other by quite narrow passages, about 7 or 8 feet deep. The water gradually increases in depth in each division from the shore. At high water, or when it is 8 feet high over the flume at the outlet, the greatest depth in the southern division is about 70 feet, in the central 50 feet, and in the northern 62 feet. The superficial area at high water is estimated at 684 acres, and at low water, or the level of the flume, 489 acres. Adjoining the southern division there is a large meadow of about 55 acres, called "Whitney's Meadow," and also a peat meadow of about 65 acres; and adjoining the central division, near Snake Brook, which formerly flowed into the Lake, there is another piece of marsh land, and there are some small bays in other places; and the increase in the surface of the Lake, between high and low water, takes place mostly in these meadows and bays. At high water there are 125 acres which are not covered with more than 5 feet of water. When the water is but 3 feet above the flume, the peat meadow is to a great extent covered, but the Whitney Meadow and

that in the central division are mostly bare. For the purpose of preserving the purity of the water, dams were built separating the Whitney Meadow, and also that near Snake Brook, from the rest of the Lake, as recommended by Messrs. Jerviss and Johnson, the Water Commissioners in 1845. They also proposed to remove the peat from the other meadow for the same object. The other parts of the shore are generally a bold sand or gravel bank. The outlet dam, and also the gate-house at the commencement of the aqueduct, are placed in the northern division.

Dug Pond, a very important tributary to the Lake, is situate near the southern division, and consists of 44 acres of very pure water, elevated considerably above the level of the Lake, and surrounded by quite high gravelly banks. It is separated from the peat meadow by the Central Turnpike, beneath which it is conducted, through a culvert, into the meadow, and flows over it into the Lake.

The water-shed, or tract of country which is drained into the Lake, is bounded by the range of hills which separates the streams running into Concord River from those which run into Charles River, and is estimated to contain 11,400 acres, after deducting the lake, and also several ponds which probably lose by evaporation most of the rain which falls upon them. There is probably more than 1000 acres of marsh land in the water shed.

It was deemed important to ascertain, as far as practicable, whether the deterioration of the water during the past year was peculiar to Lake Cochituate, or whether other lakes and ponds have not been subject to the same trouble. As far as the Board have been able to institute any inquiries, they have found that the difficulty has by no means been confined to the Lake. Among others, *Round Pond*, near Haverhill,



and which supplies that town, was examined by the City Engineer, and some of the water brought to this City. It was precisely similar in taste to the Cochituate water. There was also sufficient evidence that *Jamaica Pond* had been in the same state recently. The waters of the latter pond, which are usually exceedingly pure, some years since were for a time quite offensive both to the taste and smell. The cause of the impurity, however, was never discovered. It has, indeed, been stated, in a communication made to the Board in November last, that it proceeded from an oil "which investigation showed was from decomposing remains of *dead eels*;" and the author then attributed the impurity of the Cochituate water to a similar cause. This, however, we take to be a mistake. We are assured by the gentleman who had the entire charge and care of that pond at the time presumed to be alluded to, as the offensive character of the water was then quite notorious and it has not been so at any other time, that the origin of the evil could not be ascertained, but that there was no appearance of dead fish in the pond or the water pipes; and we are also assured by the scientific chemist who analyzed the water at the time, that he could discover no trace of animal matter in it. We are inclined therefore to believe that the cause of the offensive character of the Jamaica Pond water was then as much a subject of speculation as that of the Cochituate water is now.

There is also proof that *several wells* near the Lake and in other places have had their water affected in a similar way; and also that the water in the *Chicopee River* was for a time quite offensive.

A communication from George C. Carpenter, Esq., Superintendent of the Water Works at *Albany*, to the City Engineer, describes some occurrences which took

place in relation to the state of the water there in 1853, bearing a marked resemblance to what has happened here. In October of that year, complaints began to be made of a nauseous fishy taste in the water, which at first was supposed to be caused by small fish being lodged in the supply pipe. The evil, however, became soon so universal that it was obvious that the cause instead of being local was general. In some places the taste, accompanied by a peculiar smell, was very offensive, while in others it was scarcely perceptible; and some places were affected several days previous to others only 330 feet distant, in the same street, with a free circulation, the mains being connected and on the same plane. The taste also affected individuals very differently. Some thought it fishy, and to others it had the taste of cucumbers so strong, that there was nothing else to which it could be adequately compared. A thorough examination was made at once; and the Superintendent is of opinion that he traced the source of the evil to a grass which was found growing in great profusion along the margin of the lake, from whence the water is drawn. The plant had shed a large quantity of seeds along part of the margin, and he found the water above it offensive, and when the water lying upon the seed was taken into the mouth, he thought it impossible to doubt the origin of the impurity. The taste of the seeds was also highly offensive.

*Rensselaer Lake*, whence the supply is derived, was formed by building a dam across a creek and confining the water within it. The unusual rain fall of that year had raised the water so high that, for a width of several feet along the entire margin, it covered a luxuriant growth of the grass before mentioned. On the presumption that this was the origin of the impurity, the water was immediately reduced to its former level,

beyond the reach of the plant, in the course of a few days it was sensibly improved, and in three or four weeks it attained its usual purity.

From all the evidence therefore which has thus far been obtained on this subject, the Board are of opinion that the recent impurity in the water, from whatever source it may have arisen, has been by no means peculiar to Lake Cochituate, but has infected other ponds and collections of water in the same manner and to the same extent. They are not without proof also, that the same thing has been observed in the Lake in past years, though at a distant period of time.

The remote cause of the impurity, the Board are still disposed to attribute to the long drought and hot weather which prevailed during the past season, by which the water was unusually reduced in the Lake, and a large extent of marsh and peat land connected with the Lake and over the water-shed, was either entirely exposed, or but slightly covered with water; by which animal and vegetable decomposition must have been greatly promoted, and the products washed or carried into the Lake by the rains which began to fall about the time when the offensive condition of the water was first perceived.

If the cause thus assigned were absolutely demonstrable as the true one, it would perhaps be expedient to adopt at once the necessary measures to prevent the recurrence of the evil hereafter, or at least to diminish it; by stopping the flow of water from the peat meadow into the southern division of the Lake, and conducting the water through it in some way, so as to be untainted by any mixture with it; as is suggested in the report of the City Engineer—or by removing the peat; and thus carrying out the plan originally proposed, as has been stated, by the Water Commissioners, who early ex-

pressed their fears that the water might be contaminated by it. The expense attending the latter operation is probably one reason why it was not effected at first. The exemption which we have experienced from all the untoward consequences which were feared, and which encouraged the hope that they would never be realized, has been the reason for not doing it since. Both these projects however, would now seem to demand the earnest consideration of the Board, and it will accordingly be given.

The Board do not at present deem it expedient to adopt any of the other modes of purification which have been proposed. Their value and importance would seem to depend almost entirely, on the weight to be attached to the conjectures, which the reasoning or fancy of their authors have given rise to, as to the causes of the trouble. The Board have no satisfactory evidence of the existence of any of the causes which have been thus suggested. There is no appearance of the number of fish in the Lake being too abundant, as is supposed to be the case by some ; nor that it is too much diminished, as is assumed by others. In fact, their numbers and variety appear to be the same as heretofore. There are no symptoms of any sickness or disease among them ; and there is not, nor has there been the slightest appearance of the decomposing remains of dead fish of any kind, or of any other animal matter, in the Lake, reservoirs, or mains, or in the water flushed off from the mains ; all which have from time to time been assigned as causes of the deterioration. There has been also some suspicion expressed of the action of a volcano. The presence of dead fish or fish oil in the water, was however, the first suggested cause, and is still, by some, pertinaciously adhered to. In discrediting it entirely, the Board and



the chemists employed by them, are directly at variance with the publicly expressed opinion of a well known chemist, whose judgment is of course worthy of respect; and also, with that of a considerable number, whose opinion is founded more on a fancied resemblance of the taste or smell, than any thing else. This similarity of taste is, indeed, not perceived by—it is believed—the great majority of water takers; to whom the taste appears to be a vegetable one, and is most frequently compared to that of cucumbers. But the idea of its proceeding from animal decomposition being once admitted, it is difficult to be got rid of, especially when efforts are perpetually making to confirm it.

The only reason which has been assigned, independent of those derived from the taste and smell, is the presence of an oil, said to be a fish oil, which has been detected in the water; the origin of which is assumed to be the same with that which infected Jamaica Pond some years since, and which is stated to have been proved on investigation to have been derived from dead eels. We have no evidence, however, of the identity of the origin of the oils, nor of the source whence it was derived in the case of Jamaica Pond, as we have before mentioned. It is also alleged that an oil has been found in certain animalculæ, which have recently increased very greatly, both in number and size, as ascertained after five years' daily observation, which vitiates the water in a similar way; that these animalculæ, or crustaceans as they are called, are carnivorous, and live on the decomposing remains of dead fish, doing the duty of scavengers.

With regard to the supposition of an increase in the crustaceans,—as it is opposed to the results of all examinations which have been made by others, from time to time; and is not indeed confirmed by general experience,

as it would be if the increase were large and extensive enough to produce the effects contemplated,—it is most probable that the observations were made on water drawn from some locality where it was exceptionally affected. And in relation to the nature of the oil, and the habits, economy and duties of the creatures which produce it, the Water Board do not feel called upon to express any opinion, until those who are more skilled in researches into such matters come to some agreement among themselves on the subject. They can only profess their entire and absolute disbelief in the way thus devised, of accounting for the recent state of the Cochituate Water; and would refer to the supplementary communication of Prof. Horsford.

The Water Board have to regret that the expectations which had been encouraged of a speedy termination of the evil, were not completely realized. Their own observation and the information which they received from different parts of the City, induced them to believe, however, that about the middle of January, or a little sooner, a decided improvement had begun in the water in the City, though it was still offensive, and at some times and places more so than at others. Near the surface of the Lake it was then comparatively pure, but at the depth of 25 or 30 feet, in the northern division, the repulsive taste continued about as manifest as it was previously. In the other divisions it was almost entirely tasteless. It was also discovered that the water of Dug Pond, whose purity had never before been suspected, had undergone a similar deterioration, and, at a depth of 25 feet, closely resembled that of the northern division; at the surface, however, it had no offensive taste whatever.

An unavoidable delay which has occurred in the ascertaining some of the details of the report, has

enabled the Board to continue their record on the subject beyond the time fixed by the ordinance for its completion. It enables them to state that the improvements supposed to have been commenced about the middle of January, went on increasing till the first of February; and at that time, the water at the Lake seemed to have acquired its former purity. Taken from every depth in the northern division, it was entirely tasteless—that in the other divisions had been so, for a short time previous; and various returns which they received from different parts of the City, seemed to afford them the assurance that the same thing had taken place there. In most places where the deterioration was marked and decided, there is now no appearance of it, and in all there is a great and manifest change. We are also inclined to believe that in some places where the alteration is supposed to be less than in others, the difference may be owing to the stagnation in *dead ends*, or where the circulation is imperfect or retarded.

Respectfully submitted,

THOMAS WETMORE, *President.*

HENRY B. ROGERS,

ADAM W. THAXTER, JR.,

THOMAS SPRAGUE,

CHARLES STODDARD,

WILLIAM WASHBURN,

SAMUEL HATCH.

*Cochituate Water Board.*





## RECEIPTS AND EXPENDITURES.

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STATEMENT OF ALL EXPENDITURES MADE BY THE COCHITU-  
ATE WATER BOARD, FROM DECEMBER 31ST, 1853, TO JANU-  
ARY 1ST, 1855.

Blacksmith's Shop, for Stock, &c.,	-	\$219.85
Plumbing " " " "	-	64.98
Cartage, Boston,	- - -	73.45
" East Boston,	- - -	51.88
Travelling Expenses,	- - -	553.75
Salaries,	- - -	9,028.26
Office Expenses, for rent, fixtures, &c.,	-	2,589.68
Postages,	- - -	22.73
Expresses,	- - -	19.79
Stationery,	- - -	144.28
Printing,	- - -	136.22
Advertising,	- - -	11.00
Recording Deeds, &c.,	- - -	13.50
Miscellaneous Expenses, for examining		
pipes, water, &c.,	- - -	1,108.31
Taxes,	- - -	957.92
Oil and Wicking,	- - -	87.24
Tools,	- - -	796.95
Fountains,	- - -	347.88
Beacon Hill Reservoir, for labor, &c.,		195.47
South Boston " " -	-	151.84
East Boston " " -	-	165.56
Brookline " " -	-	854.63
Aqueduct Repairs, for labor & materials,		4,023.48
Lake Cochituate, for labor, &c.,	-	386.64

*Amount carried forward,*

\$22,005.29

<i>Amount brought forward,</i>				\$22,005.29
Tolls and Ferriages,	-	-	-	119.70
Service Pipes,	-	-	-	65.81
"    "    Boston,	-	-	-	2,566.79
"    "    S.    "	-	-	-	1,030.88
"    "    E.    "	-	-	-	3,193.64
Water Pipes,	-	-	-	12,006.81
"    "    Boston,	-	-	-	134.35
"    "    S.    "	-	-	-	14.74
"    "    E.    "	-	-	-	308.56
Hydrants,	-	-	-	263.96
"    Boston,	-	-	-	8.38
Hydrant Boxes,	-	-	-	160.05
Stop Cocks,	-	-	-	1,664.49
"    "    Boston,	-	-	-	167.19
"    "    S.    "	-	-	-	167.08
"    "    E.    "	-	-	-	167.18
Stop Cock Boxes,	-	-	-	20.06
Union Stop Cocks,	-	-	-	73.75
Laying Water Pipes,	-	-	-	212.59
"    "    "    Boston,	-	-	-	141.14
"    "    "    S.    "	-	-	-	782.36
"    "    "    E.    "	-	-	-	94.10
Water Meters,	-	-	-	53.66
Repairing Streets, Boston,	-	-	-	557.42
"    "    S.    "	-	-	-	88.64
"    "    E.    "	-	-	-	101.89
Repairing Water Pipes,	-	-	-	79.41
"    Service    "	-	-	-	24.00
"    Stop Cock Boxes,	-	-	-	7.12
"    Hydrants,	-	-	-	37.60
Marlboro Reservoir,	-	-	-	16.50
Whitehall    "	-	-	-	213.48
Rents,	-	-	-	103.26
Land Damages,	-	-	-	296.82
Land and Water Rights,	-	-	-	14,713.52--39,656.93

*Amount carried forward,*

\$61,662.22

<i>Amount brought forward,</i>				\$61,662.22
Water Works, East Boston,	-	-	80.65	
Water Works, Boston,	-	-	74.19	
Damages, Boston,	-	-	101.24	
"    E.    "	-	-	27.00	
Jamaica Pond Aqueduct,	-	-	29.53	
Cash, for sums received of H. Richardson, for rents,	-	-	93.75	
Stable, for grain, repairing vehicles, &c.,			528.02	
Repair Shop, for stock, &c.,	-	-	247.42	1,181.80
				<hr/>
				\$62,844.02

*Amount paid for Labor, viz :*

Letting on and Shutting off Water,	-	2,890.27	
Blowing off Hydrants,	-	794.05	
Laying Water Pipes, Boston,	-	1,506.53	
"            "    S.    "	-	384.73	
"            "    E.    "	-	505.01	
Laying Service Pipes, Boston,	-	1,520.58	
"            "    S.    "	-	295.22	
"            "    E.    "	-	1,032.26	
Blacksmith's Shop,	-	750.88	
Plumbing            "	-	556.06	
Proving Yard,	-	2,588.02	
Repairing Streets, Boston,	-	327.71	
"            "    S.    "	-	34.74	
"            "    E.    "	-	21.75	
"    Water Pipes,	-	1,169.74	
"    Service    "	-	1,442.60	
"    Hydrants,	-	799.04	
"    Stop Cocks,	-	142.22	
Miscellaneous,	-	960.73	
Jamaica Pond Aqueduct,	-	109.64	17,831.78

*Amount carried forward,*

\$80,675.80

*Amount brought forward,* \$80,675.80

**Cr.**

Marlboro' Reservoir, for rent,	-	-	150.00	
Whitehall " "	-	-	173.77	
Rents, - - - - -	-	-	169.68	493.45

*Amount of Expenditures,* \$80,182.35

*Cash paid City Treasurer,*

For Rents, &c., at Saxonville,	-	265.00	
" " " Wayland,	-	193.30	
" " " Needham,	-	8.50	
" " " Brookline,	-	8.87	
" " " E. Boston,	-	14.00	
" " " S. Boston,	-	8.00	
" Lumber,	-	5.00	
" Derrick, Chains and Pipes, &c.,		409.86	
" Discount on Taxes,	-	32.36	
" Old Carpets, - - - -	-	60.42	
" Materials, Labor, &c., - -	-	2,698.54	
" Land in Framingham,	-	100.00	
" " Brookline,	-	756.56	
" Notes for Land in Framingham,	-	350.01	
" Notes for Land in Brookline,	-	2,269.68	2,619.69

*Amount paid by the Service Clerk,*

For Service Pipe and laying,	1,892.69		
" Shutting off and letting on water,	-	1,888.50	
" Shutting off water for waste,	-	1,462.00	5,243.19
			12,423.29

Balance, \$67,759.06

*Amount of Expenditures brought forward,* 80,182.35

*Payments made by the Cochituate Water Board, for unsettled claims and extension of the work, viz :*

UNSETTLED CLAIMS.

Land and Water Rights, - - - 14,713.52

EXTENSION OF THE WORK.

Main Pipes, - - - - 12,464.46

Service Pipes, - - - - 6,757.12

Hydrants, - - - - 272.34

Stop Cocks, - - - - 2,165.94

Labor laying Main Pipes, - - 2,396.27

Materials " " " - - 1,230.19

Labor " Service " - - 2,848.06

" at Proving Yard, - - 2,588.02

Tools, - - - - 796.95 46,232.87

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Amount of current expenses, \$33,949.48

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*Statement of the Expenditures and Receipts on account of the Water Works, to January 1st, 1855.*

Amount drawn by the Commissioners, \$4,043,718.21

" " " Water Board of 1850, 366,163.89

" " " C. W. Board of 1851, 141,309.23

" " " C. W. Board of 1852, 89,654.20

" " " C. W. Board of 1853, 89,854.03

" " " C. W. Board of 1854, 80,182.35

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\$4,810,881.91

Amount paid into the City Treasury

by the Commissioners, - - 47,648.38

Amount paid into the City Treasury

by the Water Board of 1850, - 8,153.52

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*Amounts carried forward,* \$55,801.90 4,810,881.91

<i>Amounts brought forward,</i>		\$55,801.90	4,810,881.91
Amount paid into the City Treasury			
by the C. W. Board of 1851,	5,232.38		
Amount paid into the City Treasury			
by the C. W. Board of 1852,	15,869.12		
Amount paid into the City Treasury			
by the C. W. Board of 1853,	4,621.40		
Amount paid into the City Treasury			
by the C. W. Board of 1854,	12,423.29	93,948.09	
			\$4,716,933.82
Sundry payments by the City,	41,597.73		
Discount and interest on loans,	1,841,693.58	1,883,291.31	
			\$6,600,225.13
Sundry credits by the City, - -	1,203.17		
Amount rec'd for Water Rents, &c.	926,622.31	927,825.48	
Whole Cost of Water Works to Jan. 1, 1855,		\$5,672,399.65	

SAMUEL HOLBROOK,

*Clerk of Cochituate Water Board.*



## ACCRETIONS IN THE PIPES.

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*Cambridge, January 22d, 1855.*

THOMAS WETMORE, Esq.,

*President Cochituate Water Board.*

SIR,—A synopsis of analyses, bearing upon the important problem of protecting iron water pipes from corrosion within, embracing several hundred determinations, made during the past year, has already been submitted to you. In view of the results thus attained, it is not too much to say, that the cause of the accretion has been most satisfactorily ascertained, and that all the apparent anomalies hitherto recorded, have met with a ready and natural explanation.

A somewhat extended series of practical experiments guided by the results of analysis, has led to the confident expectation that it will be possible to protect iron effectually against this kind of corrosion and accretion. The results of analysis and experiment will better appear together, and as the latter are not yet concluded, I beg to delay the presentation of my report, until the research is ended.

I have the honor to be,

Very respectfully,

Your ob't serv't,

E. N. HORSFORD.

## REPORTS

### ON RECENT IMPURITIES IN THE WATER.

(N. B. *The specimen of water delivered to Prof. Horsford, November 16, was taken from house No. 16 Boylston street, as was also that delivered to Dr. Jackson, and marked No. 2; that marked No. 4 was from the Lake.*)

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#### PROF. HORSFORD'S REPORT.

THOMAS WETMORE, Esq.,

*President of the Cochituate Water Board.*

SIR:—The undersigned respectfully reports upon the investigation of the recent peculiar taste observed in the Cochituate water, as follows:—

About the middle of last October complaints were made of an offensive taste in the Cochituate water from particular localities in the City. As time advanced, the complaint became more general, until at length nearly all quarters of the City suffered alike from the impure water. The taste was by some thought to resemble that of fish oil, by others that of a cucumber wilted and beginning to decay, and by still others, that of the water of a stagnant pool in summer.

It is well known that from time to time fish and eels have found their way from reservoirs into service pipes, and dying, have imparted to the water an offensive taste and odor. It has frequently happened in the Croton pipes of New York, and occasionally in the Cochituate pipes. It occurred in the Spring of 1851, when, for a time, the strainers of the Brookline reservoir were out of order. These strainers, though effectual against large fish, would not exclude the young and

very small ones. Such, entering, might increase in size, and from various causes die and be carried into the service pipes. These considerations, together with the fact that an oily substance may be extracted with ether from a filter some time in use, and the peculiar odor which exhales from the filter, to which the epithet "fishy" had been applied, have lent natural support to the view that the cause of the offensive taste and smell was to be sought in decaying fish and eels.

If this were the correct explanation, an annoyance so general should have a correspondingly extensive cause, and dead fish ought, at least occasionally, to have been noticed by the water officers at some of the numerous wastes which have been kept open by order of the city engineer; and on reversing filters, fish scales and bones should have been frequently found. But so far, no fish and no remains of fish, have been seen by the water officers to pass from the pipes since last July. Some small white fragments caught upon a filter that had been several days in use, and which were described as pieces of the muscle of fish or eels, proved, upon microscopic and chemical examination, not to be animal matter of any description whatever, but lumps of starch, derived doubtless from the seeds of shrubbery or trees, growing on the shore of the lake.

An oily matter extracted from the same filter by ether, proved to be the wax of the chlorophyl (green coloring matter) of the microscopic plants, which have been present at all times, and now abound in the water.

The question of the taste being due to the presence of decaying fish or eels in the pipes is, however, set at rest by the consideration that the offensive water was remarked at the Brookline reservoir and at Lake Cochituate, where, with every opportunity for careful observation, no dead fish or eels have been found.

The water within the gate house, at the entrance to the aqueduct, was less offensive than that observed in the City. It was drawn from several feet below the surface of the Lake. That at the surface in the open Lake, was tasteless. From depths of 20, 30, 40 and 50 feet, the water had the

cucumber taste, but not so marked as that in Boston. These samples from various depths were found to have identically the same quantity of foreign matter, and to differ but little from the water in Boston of the same and previous dates, as the following determinations show :—

In 100,000 parts.		
Cochituate in Boston in Sept., 1848,	-	5.30
Another locality, - - - - -	-	5.30
Nov. 16, 1854,	-	5.26
Nov. 27,	-	5.25
Cochituate Lake, Nov. 24, 20 ft. below,	-	5.50
30	-	5.50
40	-	5.50
50 at bottom,		5.50

The water being pure at the top and offensive below, suggested that the source of the impurity might be at the bottom of the Lake. It is not unusual for accumulations of organic matter overflowed by water, to undergo fermentation imparting bad flavor to the water, injurious to the fish inhabiting it, and, from its exhalations, an annoyance to residents in the neighborhood. The part of Lake Cochituate lying nearest the junction of the Saxonville branch with the Worcester Railroad, and separated from the main body by a dam, passed through fermentations of quite an extensive character in the years 1852 and '53, accompanied by the evolution of much gaseous matter, and the destruction of great numbers of fish—cart loads it is said. Such occurrences have been observed elsewhere, but the circumstances under which they have taken place, are well defined. There must first of all be organic matter in quantity to undergo the change, and secondly there must be elevation of temperature, with the supply and discharge of water nearly or quite cut off. It might happen where low meadow land or peat is submerged to but moderate depth, the water permitted to stand without change and lessened by prolonged evaporation.

But this phenomenon would occur to the same body of water but once or twice, and the accumulation of organic

matter having been destroyed by fermentation, the water would be no longer affected by changes at the bottom.

Now Cochituate Lake is not of recent formation. It is surrounded for the most part by gravel banks instead of meadows and marshes. It loses somewhat by evaporation, yet the total loss in a summer is but a small part of the whole quantity present at any one time. It is at low water mark in some places more than 60 feet deep; and its depth is but inconsiderably lessened even by the draught by the city supply during the period of the year when the rain falls are least. It is obvious, therefore, that Cochituate Lake has not the requisite conditions for the production of impure water by changes in the organic matter at the bottom.

It appears from representations made by the gate keeper, that in the first fortnight of October, the exhalations from the water in the neighborhood of the gate house, were extremely offensive. Before that time and later, as on the 24th of November, on the occasion of the visit of the undersigned, the atmosphere there and elsewhere about the Lake was untainted. Thus from about the end of September to the middle of October an unusual instrumentality was operative, affecting the quality of the water at its entrance to the aqueduct.

As the Brooklyn reservoir contains about one hundred and twenty millions\* of gallons of water, and as the daily consumption is about eight and a half millions,† not far from a fortnight would elapse between the entrance of bad water at the Cochituate gate house and its first appearance in the City.

The peculiar taste was, as already mentioned, first noticed in Boston about the middle of October.

Since the impure water could not have been derived from the bottom of the Lake, it must have been supplied to the surface through some of its tributaries. The character of these tributaries will be better appreciated from a consideration of the topography of the basin which is drained for the supply of the Lake. This basin contains 12,077 acres, lying

\* 119,583,960.

† In October of 1853 it was 8,542,300.



about equally north and south of the Worcester Railroad. It supplies to Lake Cochituate two kinds of water; one through springs, and the other by surface drainage, as a glance at the subjoined determinations will show.

Cochituate water, before the water works were commenced in 1845, contained of foreign matter in 100,000 parts, 3.17\*

Dug Pond, Nov. 24th, 1854,	-	-	-	"	"	4.26
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Cochituate Lake,	-	-	-	"	"	5.50
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Pond South of Worcester Railroad,				"	"	7.50
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Marsh ground in the neighborhood of the Framingham station,	-	-	-	"	"	17.00
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As nearly or quite one-half of all the water supplied to Lake Cochituate flows through the pond south of the Worcester Railroad, and as the resultant mixture of this with the supplies from other sources has a smaller measure of foreign matter, it follows that the other sources are purer. They are springs indeed, the waters of which have been purified by filtration through the soil. Cochituate Lake is, as has been already remarked, like Dug Pond, for the most part surrounded by gravelly banks, while the pond south of the Worcester Railroad communicates directly with an extensive area of peat, bog, marsh and meadow land, all the surface drainage of which finds its way through this pond to the Lake.

Bearing these data in mind, to wit, that about one-half of the water supplied to Lake Cochituate flows through the pond south of the Worcester Railroad, that this, with the exception of that derived from Dug Pond, is for the most part surface drainage, and that the other half is, in general terms, spring water, let us glance at the meteorological and other conditions of the region about the Lake during the past season.

The quantity of rain that fell in last July and August was unusually small. The average for these two months during the eleven years ending 1851, was

At Cambridge,	-	-	-	-	7.29 inches.
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Waltham,	-	-	-	-	7.09 "
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\*Silliman, Jr.

At Boston,	-	-	-	-	6.25 inches.
Lowell,	-	-	-	-	7.76 "
Average,	-	-	-	-	7.09 "

Taking this average as the quantity that probably fell at Lake Cochituate, we have from 1840 to 1851, 7.09 inches.

It was observed to be for 1852,	-	10.53	"
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" " " 1853,	-	10.04	"
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Average for the last two years,	-	10.26	"
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" " " thirteen "	-	8.15	"
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From July 1st to August 28th, of 1854, the total quantity of rain that fell was 2.60 inches, of which there fell before July 17th, 1.80 inches, leaving only .80 for the latter half of July and nearly the whole of August.

This quantity is greatly less than the evaporation during the two warmest months in the year, from the marsh and meadow land south of the Worcester Railroad. As a consequence, the smaller bodies of water distributed over this area would cease to discharge, and, with the elevated temperature, there would be, in such grounds, extraordinary development of the microscopic organisms that flourish in stagnant pools, and which are always found, more or less, in Cochituate water. With the prolonged drought, these minute forms, for the most part vegetable, would die and decay.

Another effect of the prolonged drought would be, the ascent by capillary action of soluble matters, which previous decay had formed, and which had settled into the soil.

Still another effect of the extreme evaporation and drying of the porous muck and peat-like soil, would be, its preparation for condensing any effluvia arising from the decaying matter about.

To some extent it may be conceived that an occasional fish that had followed a rivulet too far into the marshes and meadows, was cut off from return by the gradual drying up of the water, and so fell to decay.

No dead fish have, however, been observed, and the latter effect may be regarded as of inconsiderable importance.

The material that would be found ready for solution by occasional rain-falls would be the juices or extracts of dead

and decaying microscopic organisms, in more or less advanced stages of decomposition. Some would be highly volatile, others less so, and others not at all, at ordinary temperatures.

Now it appears from information obtained at the water office, that an order was given on the 16th of August to raise the dam, at the outlet of the pond south of the Worcester Railroad, and from about the 20th of August no water was permitted to escape from the pond by the way of Cochituate Lake until September 27th, when the extreme depression of Cochituate Lake, in consequence of the long continued drought, made it necessary to let in the reserved water of Dug Pond.

In the last days of August and the first fortnight of September, there fell 3.60 inches of rain. All the washings of this body of water were stored up in the pond to be carried forward with the contribution from Dug Pond.

Thus, during all this period of a month and a half, it appears that all the extracts of all the accumulations of dead and decaying microscopic vegetation of a remarkable season, and developed under circumstances peculiarly favorable to the extraordinary production of this department of organic life, spread over an area of several hundred if not more than a thousand acres, were withheld from going forward to mingle with the purer waters of the Lake.

The water that had thus fallen upon an extended warm land surface and had been drained into a shallow pond easily heated by the sun, was naturally of a less specific gravity than the main body of Cochituate Lake. Accordingly, as it entered the Lake, instead of displacing the water or driving it forward, it flowed on the top, and though mingling to some extent with the water below, the surface water was, with all its offensive attributes, pretty nearly as it passed the Worcester Railroad.

At this time, (the end of September) the unpleasant odor began to be observed at the Gate House at the entrance to the aqueduct, and soon after, the water yielding it must have spread over a great portion of the Lake. The water charged

with it was at this time on its way to the Brookline Reservoir, and a little more than a fortnight later it appeared in Boston.

On the mornings of November 6th and 7th, the temperature of the air at the Gate House was  $12^{\circ}$  F.; on the 5th it was at the same hour  $23^{\circ}$ , and on the 8th  $41^{\circ}$ . The temperature of the water below was  $53^{\circ}$ . There had been ice formed in all very shallow places, and the water at the surface of the Lake must have experienced a marked reduction of temperature. As a natural consequence the surface water sunk, and the warmer water rose to take its place. — On its way down it mingled more or less with all the water of the Lake, so that on November 24th the bad tasting water was found at all depths from 10 to 50 feet. All water flowing from the shallow meadow south of the Worcester Railroad, and the low lands drained into it, were of course colder after the 7th of November, and as they flowed in constant stream upon Cochituate Lake, they sunk to the bottom, forcing the pure water up. The total fall of rain in November, from the 1st to the 20th, amounting to 6.30 inches, had, with the gradual decline of the temperature of the air, brought the temperature of the bottom of the Lake, on November 24th, down to  $43^{\circ}$ , while at the surface it was  $44^{\circ}$ . At this date the taste of the water flowing in under the Worcester Railroad was astringent, but had little or no trace of the cucumber taste.

As the water on the 24th November at the surface of the Lake near the Gate House was sweet, and at 20 feet below was much less offensive than that in Boston, and as it takes about 15 days for water to come from the Lake to the City, it may be expected that about the 10th of this month the water in the City will begin decidedly to improve, and soon after will have regained its remarkably pure taste.

The bodies of offensive taste and smell are volatile. By passing a few gallons of water through a tube containing loose cotton, the matter ordinarily separated by a common filter may be caught, and the cotton, first absorbing, will after impart the offensive effluvium, and greatly facilitate the

perception of the odor. By corking the tube the odor may be preserved upon the cotton for days.

Water collected on the 24th of November from a depth of 30 feet in Cochituate Lake, and kept in a nearly filled and corked jug, on opening some hours after, gave in the first draught the disagreeable flavor; a short time after, it had nearly lost it. The volatile matter had risen from the whole body of water to its surface in the neck. This fact will explain the comparative exemption from bad taste of the water of particular localities, and the unequal offensiveness of the water in other parts of the City. Where the service pipe leads from the end of a descending branch, the flavor will tend to rise to the more elevated portions near the main, and if but little is drawn, the water will be less impure. Or where there is an ascending branch, the flavor might accumulate near the more elevated extreme, and the intensity of the offensiveness be modified by the frequency of use and quantity of water discharged. Confined in the pipes, there is no opportunity for the volatile bodies to escape. Drawn and permitted to stand a few hours, or boiled for a few minutes, the water loses its unpleasant flavor. Powdered charcoal recently ignited will condense the taste and odor in its pores. A pint of such charcoal so purified 31 gallons of water passed from a Cochituate service pipe directly through it, that in the last glass drawn there was scarcely a trace of unpleasant taste. It also retained the microscopic vegetable forms which appear in the first dash of water after reversing a filter, and from which ether extracts the green coloring matter Chlorophyl. This body consists, as already remarked, in part of wax, which, separated from ether, floats upon water, is yielding to the touch, may be converted into a kind of soap by alkali, and is the only oily substance that the undersigned has been able to find in the water. In conclusion :

The recent peculiar taste of the Cochituate water is, in the judgment of the undersigned, due chiefly to extracts more or less volatile from the decaying minute aquatic organisms, for the most part vegetable, which, during the late



prolonged drought, have been produced in extraordinary quantity upon the low meadows, marshes, bog and peat lands which supply the surface drainage to Cochituate Lake.

Respectfully submitted,

E. N. HORSFORD.

*Cambridge, December 7, 1854.*

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NOTE. *Since the presentation of the above Report, some new facts have been elicited, bearing upon the origin of the recent peculiar taste of the Cochituate water, which it is desirable permanently to record.*

A visit has been made to two ponds in the neighborhood of Haverhill, the waters of which, according to Dr. Nichols, have occasionally suffered deterioration. From one of them, Round Pond, the village aqueduct is supplied. During the last few months it has been noticed that the taste of Cochituate water in Boston, and that of Round Pond water in Haverhill, have been quite alike. To some the water had a fishy taste, to others, the taste of cucumbers. At the immediate surface where the ice had been removed, the water was without taste. At a depth of but two or three inches, however, the peculiar taste was distinctly perceptible. It prevailed at all depths, and more or less in all parts of the pond, except about the inlet, where the water was tasteless. The varying offensiveness of the taste in some parts of the circulation, in the village, and its total absence in others, have been noticed as they have in Boston, and are due to the same causes.

Mud procured from the bottom of Round Pond, and also from Great Pond, the other sheet of water visited, proved on chemical and microscopical examination to be like that from

Lake Cochituate, Dug Pond, and the aqueduct between Brookline and the gate house. It presented many of the forms figured in the Report of the Water Board for 1852.

With the exception of a small area of bog land on either side of the little inlet, the shores of Round Pond are gravelly knolls. No dead fish or eels have been seen within or about the pond during the past season, nor during or immediately preceding periods, when in former years, the same taste has prevailed; but the fish have been remarked to be more sluggish in their movements, just before than just after the prevalence of the unusual taste.

Dr. Nichols has suggested that the fish, by reason of the prolonged drought and suspended supply of fresh aerated water, sickened, and on the return of abundant rains, cast off simultaneously and in unusual quantity their slimy coats, which dissolved in the water and imparted to it the offensive flavor. This view is strengthened by the fact that a filter through which five hundred gallons of the water were passed, yielded an odor strongly resembling that of recently caught fresh fish. The filter yielded also on rinsing, beside vegetable forms, a large number of crustaceans, similar to those in the Cochituate, which have been examined by Dr. Bacon and Dr. Hayes, and in which, with the aid of a microscope, it was not difficult to see oil globules.

The water from Great Pond, taken from various depths, possessed very faintly the taste of that from Round Pond. Samples from both ponds became tasteless after a few hours exposure.

Jamaica Pond, which is said for many years to have had occasionally to a slight extent the same taste as the Cochituate, and for short periods, in some portions, during the last Autumn, was also visited. There was a taste astringent and a little peculiar, but not like that of the Cochituate. That at the surface and at various depths to forty feet, were alike in this respect.

Several wells in the neighborhood of Boston, have, it is said, been similarly affected during the months of September and October, and occasionally for short periods in past years.

Filters have been examined which have from time to time strained various quantities of Cochituate water, from fifty gallons to 36 barrels. In the rinsings of the first filters, no living crustaceans were seen, and with the exception of a few fragments of the legs of crustaceans and insects, and a very few inferior animal forms, the whole deposit was vegetable. In the rinsings of the later filters, the proportion of minute animal forms had increased, and still later, numerous crustaceans were visible. From the size or inclination of neighboring mains, or perhaps from the comparative quiet of the water, there would seem to be more animal forms at some points in the circulation than at others.

One of the first deposits, after being rinsed from the filter, was permitted to settle, and the water above poured off. It had the offensive taste of the Cochituate. The deposit, with a little distilled water, was then bottled and corked up, and is still preserved. Upon opening the bottle, from time to time, it continued to exhale the odor, and the water to possess the taste of cucumbers—such a taste as might have been expected from an infusion of minute algae. The water poured off from the deposit soon recovered its purity.

The deposit of a later date on a filter which had strained 36 barrels of water, and which contained, as was estimated, about one-tenth of animal forms, was bottled and corked up with a quantity of distilled water, and set aside. After a few days, on opening, it yielded an offensive odor—not of fish or cucumbers, but rather of putrefactive fermentation. The distilled water was renewed every three or four days for more than a month, and yet it continued to exhale the offensive odor. This deposit, it will be remarked, was all the insoluble organic matter of 36 barrels of water, covered by not more than half a pint of distilled water. It would probably in its dry state, not amount to more than two thimbles full.

The presence of oil globules in some of the slender animal forms, the ready extraction of them by ether, and their saponification, coupled with the peculiar odor which attends the decay of these creatures, has been conceived to lend

support to the idea that the odor was due to oil, and the oil to dead fish, upon which these minute animals have fed.

The presence of the taste at the Lake relieved the suspicion that dead fish or eels were lodged in the pipes. The absence of dead fish from the borders of the Lake, has been remarked by persons whose duties gave them frequent opportunities for observation. It is difficult to conceive how sufficient numbers of dead fish to impregnate all parts of Cochituate Lake, could be present in the water, and yet no fragments of them anywhere be found. But whatever this difficulty may be, there is another arising out of the above view, of greater moment. Oil, mingled with water by agitation, upon coming to rest, rises to the surface. Now if the taste at the Lake were due to fish oil, the surface water should have been offensive in the last degree, if not coated with a thin film of oil: whereas, in fact, the surface water has been tasteless, no oil has been observed upon it, and only the water below has been characterized by the peculiar flavor.

The facts that have been observed since the middle of December, would seem to find full explanation in the consideration that the crustaceans feeding upon inferior forms of life, (not dead fish) have merely gathered into lesser compass *portions* of the matter which the drought of the past season has developed. When they die and decay, an unusual measure of the source of unpleasant flavor is concentrated in their remains.

The following determinations may be of value for future reference.

Caught on a filter, Dec. 21, from 24 barrels of Cochituate water—

Dried at 212° Fah., 0.3320 grammes.

Deposit in the aqueduct above the Brookline Reservoir, exceedingly offensive for a few days, and then becoming tasteless—

Dried at 212° Fah., 0.8515 grammes.

Gave Organic, 0.1215 “

Inorganic, 0.7300 “

Deposit from bottom of Cochituate Lake,  
at a depth of 55 feet—

Dried at 212° Fah.,	0.2850 gr.
Gave Organic,	0.0635 “
Inorganic,	0.2215 “

Deposit from bottom of Round Pond, Haverhill—

Dried at 212° Fah.,	0.2655 gr.
Gave Organic,	0.0935 “
Inorganic,	0.1720 “

Aqueduct water at Haverhill—

400cc. gave Residue,	0.0145 gr.
Organic,	0.0070 “
Inorganic,	0.0080 “

Great Pond water, 15 ft. below surface—

400cc. gave Residue,	0.0155 gr.
Organic,	0.0075 “
Inorganic,	0.0080 “

Cochituate Lake, Dec. 21—

400cc. gave Residue,	0.0170 gr.
Organic,	0.0090 “
Inorganic,	0.0080 “



## DR. JACKSON'S REPORT.

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32 Somerset street,  
BOSTON, December 6th, 1854.

THOMAS WETMORE, Esq.,

*President of the Cochituate Water Board.*

DEAR SIR:—During the latter part of the month of October last, a peculiar flavor of an unpleasant nature was perceived in the Cochituate water delivered by aqueducts in the City of Boston, and an investigation was ordered by you for the discovery of the nature and causes of this change in the taste of the water.

On the 18th and 20th of November I was called upon by E. S. Chesbrough, Esq., the City Engineer, who sent me two demijohns of water marked "Nos. 2 and 4," with a request that I should make chemical analysis of their contents. The quantity of water in each demijohn was two gallons.

I was not informed of the source from which the waters were taken, since it was desirable to obtain my independent testimony without any possible bias being suspected by any one.

Chemical analysis of water marked "No. 2."

The taste of this water was unobjectionable, and was like that of Cochituate water when not regarded as impure. Many persons tasted it and found no unpleasant flavor or smell in it.

The water was thoroughly shaken up in the demijohn and one imperial gallon was measured out for analysis. This was evaporated at a gentle heat to small bulk in a porcelain basin, and then the evaporation was completed in a platinum capsule over boiling water. The residual matter obtained

was dried at a temperature of  $212^{\circ}$  F. and weighed 3.18 grains. The matter destructible by heat was then burned off, and gave only the odor of burning peat without any smell of burning animal matter. The loss by combustion was 1.3 grains, which is that of the vegetable matter.

The mineral substances remaining weighed 1.88 grains.

On analysis of these matters I found them to contain silica, alumina, oxide of iron, lime, traces of magnesia, soda, chlorine, sulphuric acid, and traces of phosphoric acid.

As they existed in the water these matters were chiefly  
Crenate of lime and crenate of iron. -

Sulphate of lime traces.

Sulphate of soda.

Chloride of sodium.

Chloride of magnesium.

The organic matter was examined in a separate portion of the water, and found to be chiefly crenic acid, without any apocrenic acid. No oily or animal matters were found, nor was the chlorophyle and wax subsequently discovered by me in other samples of water sought for in this water, it having all been used up in the above researches.

Water marked "No. 4."

The origin of this water was not made known to me.

No unpleasant taste or smell could be discovered in it by me or by other persons whom I requested to taste it.

One imperial gallon, equal to 70,000 grains, of this water was taken for analysis, and evaporated to small bulk in a porcelain bowl, and the evaporation was completed by a steam heat at  $212^{\circ}$  in a platinum capsule. The residual matter obtained weighed 3.4 grains, of which 1.5 grains is vegetable matter, and 1.9 grains mineral matters, consisting of silica, alumina, oxide of iron, lime, traces of magnesia, chlorine and sulphuric acid. Their proportions were

Silica and sulphate of lime,	-	-	0.30
Oxide of iron and alumina,	-	-	1.00
Lime, - - - - -	-	-	0.34
Other matters not weighed,	-	-	0.26
			<hr/>
			1.90

The principal organic acid is the crenic, derived from the decay of vegetable matters under water. No odor of animal matter could be discovered by burning the dry residue obtained by evaporation of the water.

After I had completed these analyses, I was invited to accompany you with Mr. Chesbrough and Prof. E. N. Horsford, on a visit to Cochituate lake and its environs, to examine the lake and the water shed into it, for the purpose of discovering, if possible, the origin of the foreign matters complained of in the water.

We visited all parts of the lake, tasted of the water at every tributary lake and stream, and that drawn by a hose from various depths in the lake. We found the surface water free from any unpleasant taste, it being rain water that had fallen, and which had not then commingled with the lake water, on which it rested.

Water drawn from a lower depth had that peculiar flavor which we find in the aqueduct water in Boston, and this taste was strongest at the depth of from 19 to 39 feet from the surface. We also perceived it quite strong in the water at the gate house, where a stratum 8 feet from the surface enters the conduit.

We all agreed in opinion that the taste resembled that of water in which cucumbers had been soaked. We filled several demijohns with the water, drawn from various depths of from 19 to 49 feet, samples being taken from every 10 feet in depth by means of a pump and hose attached to a sounding line and lead. These samples of one gallon each, were divided between Prof. Horsford and myself by your orders.

The temperature of the water at the gate house was  $43\frac{1}{2}^{\circ}$ , that of the air being  $53^{\circ}$ . At the bottom of the lake the thermometer stood at  $44^{\circ}$ , hence the water at the bottom of the lake is a little warmer than that of the surface. The records of the superintendent of the lake show, that during the month of July last the temperature of the water was in the gate house  $73^{\circ}$  F.

Having obtained our samples of the lake water, we next examined the stream from the Cranberry meadow, and found it tasted like rain water, and had no peculiar taste like that of the deep water of the lake. This meadow is flowed, and there are an abundance of fishes living in its waters; and we learned from a person living near the spot, that no dead fish had been seen on its shores this year, though there were great numbers of them thrown upon its shores year before last.

Dug Pond has very pure and transparent water, quite free from any taste of foreign matters. This water discharges into Cochituate Lake through Fiske's meadow, a peat bog, and in its course it becomes highly colored by a solution of peat, which gives it an amber tint, but it has no unpleasant taste. The water falls over a dam of a few feet in height, and the engineer, on gauging the water, estimates nine million gallons per day as the discharge of this water into Cochituate Lake.

We rode all around the country that is drained into Cochituate Lake, and tasted of every streamlet or collection of water, and did not observe in any of those waters that peculiar flavor which we had found in the deep water of Lake Cochituate. It would seem, therefore, that either the bad tasting stratum of water had entered the lake some time since, or that it has derived its peculiar taste from fermenting vegetable matters at its bottom.

If the bottom water had become charged with a vegetable infusion during the heat of summer and autumn, it could not rise to the surface until the top water was cooled down to such a degree as to render it denser than the water below, so as to descend and displace it.

The maximum density of water is at 39.2° F., while the water at the gate-house has been at 78° in July and August, and is now at the bottom 44°. It is evident that if the surface water during cold nights should descend to 39.2° that it would descend and displace the lower strata of water, and cause them to rise. This would take place at less differences of temperature at slower rates, exactly proportioned to the

differences of temperature, provided the upper strata should be coldest ; but the reverse could not take place, hence warm water does not descend to displace cold water, unless the temperature of the lower water should be considerable below 39.2° when it would be lighter, as may be seen from the following table, extracted from Berzelius's *Traite de Chimie*, Vol. 1st, p. 365.

Table of the density and volume of water, unity being taken at the temperature of the greatest density of water, 4° C.=39.2 F.

Temperature.		Specific Gravity.		Volume.		
0	-	-	0.9998918	-	-	1.0001082
1	-	-	0.9999382	-	-	1.0000617
2	-	-	0.9999717	-	-	1.0000281
3	-	-	0.9999920	-	-	1.0000078
*4	-	-	1	-	-	1
5	-	-	0.9999950	-	-	1.0000050
6	-	-	0.9999772	-	-	1.0000226
7	-	-	0.9999472	-	-	1.0000527
8	-	-	0.9999044	-	-	1.0000954
9	-	-	0.9998497	-	-	1.0001501
10	-	-	0.9997825	-	-	1.0002200
11	-	-	0.9997030	-	-	1.0002970
12	-	-	0.9996117	-	-	1.0003888
13	-	-	0.9995080	-	-	1.0004924
14	-	-	0.9993922	-	-	1.0006081
15	-	-	0.9992647	-	-	1.0007357
16	-	-	0.9991260	-	-	1.0008747
17	-	-	0.9989752	-	-	1.0010259
18	-	-	0.9988125	-	-	1.0011888
19	-	-	0.9986387	-	-	1.0013631
20	-	-	0.9984534	-	-	1.0015490
21	-	-	0.9982570	-	-	1.0017560
22	-	-	0.9980489	-	-	1.0019549
23	-	-	0.9978300	-	-	1.0021746
24	-	-	0.9976000	-	-	1.0024058
25	-	-	0.9973587	-	-	1.0026483
26	-	-	0.9971070	-	-	1.0029016
27	-	-	0.9968439	-	-	1.0031662
28	-	-	0.9965704	-	-	1.0034414
29	-	-	0.9962864	-	-	1.0037274
30	-	-	0.9959917	-	-	1.0040245



I have copied the degrees as given centigrade, in order to avoid the fractions which would result from the reduction of them to the Fahrenheit scale.

Those who wish to convert any of the degrees centigrade to Fahrenheit, have only to multiply the centigrade degrees by 9, divide the product by 5, and add 32°.

43° F. is equal to 6.11° centigrade.

44°        “        6.67°        “

73°        “        22.78°        “

By comparing these degrees with the table above given, the relative specific gravity of water at these temperatures will be seen, and may be compared with that at 4° C. or 39.2° F. as unity. This table may be useful to engineers of water works, and therefore I recommend its publication in the Water Report.

It is well known that the bad taste of Cochituate Lake water came on soon after the sudden cold weather of the middle and latter part of the month of October, and perhaps this sudden change of temperature may account for the rising of the lower strata of water, so as to cause them to run into the conduits.

Again, it has been supposed that the sudden fall of the forest leaves, full of their juices at the time, and charged with green chlorophyle may account for the singular fact of the appearance of this vegetable coloring matter in the water of the lake, for the heavy rains that fell soon after the fall of the leaves, would wash much of this matter (set free by fermentation,) into the Lake. It is also highly probable, that the wax and vegetable oil came from fermenting foliage.

The mucilaginous matters in leaves of trees undergoes a rapid fermentation when kept moist, and gives rise to various disagreeable products which differ with the nature of the foliage.

It is probable therefore, that we may be able to trace the peculiar taste of Cochituate water to some such source.

*Chemical analysis of Water taken from Cochituate Lake, November 24th, 1854. Water drawn 19 feet below the surface of the Lake.*

It has the flavor of water in which cucumbers have been soaked, but has not any perceptible odor.

One imperial gallon, equal to 70,000 grains weight, evaporated carefully to small bulk by a moderate heat, and the evaporation completed in a platinum capsule at 212° left 3.223 grains of brown matter, which adheres to the platinum.

This digested in ether, and again dried to 212 lost 0.093 grains. The ether evaporated in a small capsule, left a rim of green matter, identical with that which by other experiments on the aqueduct water, I have previously proved to be chlorophyle and wax with a little fixed oil.

The remaining organic matter, which was insoluble in ether, I burned off, and found to amount to 1.430 grains, and the mineral matters left amounted to 1.800 grains. The results were:—

Chlorophyle wax and oil,	-	-	-	0.093
Vegetable matters insoluble in ether,	-	-	-	1.430
Mineral matters,	-	-	-	1.800
				<hr/>
Whole contents of one gallon,				3.323

The water drawn from a depth of 49 feet, which is about 10 feet from the bottom of the Lake opposite the gate house, was found to give but 3.2 grains of solid matter per imperial gallon, and was in all respects like that obtained at the depth of 39 feet, and does not essentially differ from that of 19 feet depth in the quantity of foreign matters contained in it, though the lower water appeared at the time it was drawn to be a little more charged with the cucumber taste.

This flavor I find to be extremely evanescent, for it disappears in three or four days wholly from the water, even when it is closely corked up in demijohns and kept in a cool place.

So it was found that when we had put up demijohns of the aqueduct water, while it tasted most strongly, and after a few days uncorked them to taste the water or to submit the samples to chemical examination, the peculiar flavor would be entirely gone, and the water was found to be in every respect quite sweet and good. The same fact has been noticed by numerous persons in this City, and is well known at the water board office, where samples of the worst tasting water became quite good in less than a week after they were left at the office by complainants. This I have verified by numerous experiments, and by inquiry of others. Thus, when the water is contained in a tank in the upper part of a house, it loses its disagreeable flavor, while that drawn directly from the pipes has in it a marked degree.

So we found when we visited the dead ends of the water pipes, where but little water was drawn, that no unpleasant taste had ever been perceived by those using it. The water had undergone the same changes in the iron pipes which we had noticed in that we had kept in demijohns. This we observed most remarkably in a dead end of the pipe on the mill-dam, while we found the water at the reservoir possessing the cucumber flavor.

The "flushing off" of the pipes has, as I learn, in most every case augmented the complaints against the water, and thus still farther proved our opinion to be correct, that the impurities are in the Lake itself, and not in the pipes.

In stating this opinion, I would not wish to be understood as denying that, in some particular cases, there may have been found fishes in the distribution pipes. Their occasional occurrence is fortuitous, and cannot always be entirely avoided, but what I wish to say is that the general bad taste in the water is not derived from fishes, nor from any animal matter whatever in the water, or in the main pipes of the aqueduct.

The matters present are all of a vegetable origin, and the substance giving the peculiar bad flavor is so readily decomposable, as to undergo entire decomposition, so as to disappear in a very short time. I therefore confidently predict

the speedy return of Cochituate Lake to its accustomed purity.

Perhaps the sealing up of the Lake by ice, which will soon form, will aid in changing the character of the water, since we have observed that the water closed up in our jars, and in water pipes and in tanks, becomes speedily pure.

I may also call your attention to the important fact that since the aqueduct was laid Cochituate water has been gradually improving, and now does not contain but little more than half as much solid matter per gallon as it did in 1845. I refer to my analyses published by the water Commissioners of that year in proof of this point, and beg leave here to append an extract from that report :—

*Extract from Dr. C. T. Jackson's Report of Analysis of  
Water of Long Pond, Natick.*

Boston, February 1st, 1855.

“ Messrs. Wm. Parker, James Hayward, and T. B. Curtis.

GENTLEMEN :

At your request I visited Long Pond, in Natick, on Tuesday last, and obtained specimens of the water from each of the three divisions of that pond, and have since made a chemical analysis of each sample, the results of which I now communicate.

Specimen No. 1 was taken thirty rods from the shore, and opposite the place where, according to the plan given me by Mr. James F. Baldwin, the proposed aqueduct is to commence.

No. 2 was taken near the middle of the central division of the pond, nearly opposite the house of Widow Coggins, and four hundred paces from the shore.

No. 3 was taken from near the middle of the upper division of the pond, opposite the house of Mr. Morse, and about four hundred yards from the shore.

The water was obtained by cutting holes through about ten inches of ice, and was drawn up by means of a tin bucket, and poured into clean glass jars and demijohns,

which were closely stopped, and brought to my laboratory in Boston for analysis.

*Chemical Analysis of the Water of Long Pond.*

One imperial English gallon, equal to 70,000 grains of distilled water at 60° F., or to 277.274 cubic inches in bulk, of each sample, yield the following amounts of vegetable and mineral matters, when evaporated to entire dryness, and on separation of the ingredients.

*Long Pond Water No. 1 (Lower Pond).*

Vegetable matter destructible by heat,	2.4 grains.
Mineral matter (earths and salts),	3.6   “
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Whole contents of one gallon of the water,	6.0   “

*Long Pond Water No. 2 (Middle Pond).*

Vegetable matter destructible by heat,	1.64 grains.
Mineral matter (earths and salts),	3.88   “
	<hr/>
Whole contents of one gallon of the water,	5.52   “

*Long Pond Water No. 3 (Upper Pond).*

Vegetable matter destructible by heat,	1.42 grains.
Mineral matter (earths and salts),	2.90   “
	<hr/>
Whole contents of one gallon of the water,	4.32   “

The vegetable matter consists of the usual organic acids of the soil, which are combined with the earthy bases, lime, magnesia, and with oxides of manganese and iron. These bases are separated by combustion of the vegetable acids, the lime and magnesia which they contained, being converted into carbonates of lime and magnesia.

The salts are chloride of sodium, or sea salts, sulphate of lime or gypsum, and sulphate of soda, which are found in the mineral matter, mixed with a minute quantity of clay and phosphate of lime, and the earthy bases derived from the combustion of the organic acid, compounds before noticed.



The foreign matters in this water are in such small proportions, as in no way to impair its healthfulness as a drink, nor will they prove injurious in washing clothing.

It is somewhat remarkable that the water of the upper division of the pond should prove the purest, considering the fact of its overflowing a small peat bog or cranberry meadow, during this season of the year. This must result from the influx of purer water from a neighboring pond, which empties into Long Pond, by a small stream, traversing the meadow."

At the suggestion of friends I made a chemical examination of the water from my aqueduct, during the period when the water had the strongest flavor, and directed my researches particularly toward the discovery of animal oils in the water.

I prepared a bone black filter expressly for the purpose of collecting any oleagenous matters that might be in the water, and allowed the water from my aqueduct to trickle through this filter continually in rapid drops for 24 hours.

I then took the bone black, and having dried it at a very moderate heat, subjected it to the action of ether. I then filtered off the ether, and evaporated it in a current of warm air to dryness. A yellow substance was obtained, which was fluid while warm, and which dried on the sides of the vessel. It was repeatedly dissolved in ether and examined. It rendered a piece of unsized paper translucent, and acted like a mixture of wax and oil. It did not saponify with a strong solution of carbonate of soda, though long boiled with it, but floated on the surface of the hot solution, and separated as it cooled in a flake or floating crust. It was mostly soluble in alcohol, and the alcohol left no oil globules. Boiled with caustic potash, it saponified like wax. It had none of the properties of fish oil, and no odor even when acted upon by caustic potash, and by sulphuric acid. There may have been present some small proportion of fixed vegetable oil, but no animal oil could have existed in it. The softness and fusibility of the wax indicated the presence of a small proportion of a fixed oil.

I had a felt filter bottom brought to me by Mr. Holbrook, the clerk of the Water Board. This filter had been used for

a week, the water having been run through it continually. I examined it by dissolving out the green matter with absolute alcohol, and proved it to be chlorophyle. I dissolved out next whatever was soluble in ether, and found wax and some chlorophyle. This filter furnished enough of the green matter to enable me to pass it through all the usual tests to prove its nature. Part of it was soluble in acetic acid, and part not, the matter left being vegetable wax. I could not find any oil in the matter taken up by ether from this filter.

In connection with this subject, I made a series of direct experiments on the oil obtained by maceration of eels in water, examining both the fresh and the rancid oil, and the odors produced during their saponification, and that given out from them by the action of sulphuric acid, and am prepared to state confidently, that there is no such oil in any of the waters which have been examined by me for its presence. Fish oil is, when in water, quite permanent, and would be seen floating on the surface and would not disappear by being kept in a demijohn for a few days, therefore the matter which gives the peculiar flavor to Cochituate water cannot be fish oil nor any animal oil.

In order to compare the amount of matters contained in water drawn directly from the Lake, with that in the water from the aqueduct pipes in Boston, I took an imperial gallon of the water from my own aqueduct, and submitted it to analysis with the following results.

Analysis of water from my aqueduct :—

An imperial gallon of the water was evaporated to small bulk in porcelain, at a simmering heat, and the evaporation was completed in platinum at  $212^{\circ}$ . An oily film was seen on the surface of the water, but it was not in globules, but in a delicate film. Great care was used not to decompose this matter, and it was separated by ether and found to be chlorophyle and wax, not a globule of oil being separated from it when it was acted upon by alcohol and by acetic acid.

This analysis was repeated the next day, to determine the proportions of matters soluble in ether, and those not soluble,

One gallon of the water gave 3.1 grains of solid matter, dry at 212°.

Of this, there was soluble in ether, chlorophyle and wax,	-	-	-	-	-	-	-	0.09
Vegetable matter not soluble in ether, (the usual vegetable matters of the water,)	-	-	-	-	-	-	-	1.20
Mineral matters,	-	-	-	-	-	-	-	1.81
								<hr/>
								3.10

This analysis shows that there is very nearly the same amount of matters soluble in ether in the aqueduct at my house, as there is in the water obtained directly from the Lake, while the total solid contents of the water from the pipes is a trifle less.

This analysis is important as showing the relations between the water delivered in the City and that of the Lake.

In conclusion, I would assure you and the citizens of Boston, that there is good reason to believe that the unpleasant taste of Cochituate water is rapidly passing away; from operations naturally taking place in the Lake, and that the water will probably soon be as good as ever.

I regret as much as any one that we have not been able to settle all the interesting questions that have arisen as to the origin of the impurity complained of. Thus much we have done. We have proved that the peculiar taste of the water does not originate within the pipes, but exists at the fountain head, and that it is not the result of animal putrefaction, but of vegetable fermentation, and that there is nothing deleterious in the water. These are some points gained. In time we may search out the other matters, should the evil ever again recur.

I have the honor to be, with great respect,

Your obedient servant,

CHARLES T. JACKSON, M. D.,

*Assayer to the State of Massachusetts, and to the City of Boston*













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